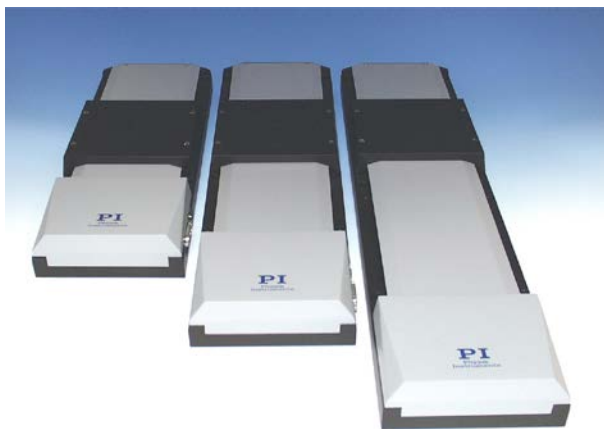


MP113E M-5x1 Stages User Manual

Version: 1.0.0

Date: 25.09.2013



This document describes the following micropositioning stages:

- M-5x1.DD1:
with ActiveDrive DC motor, PWM, linear encoder
- M-5x1.DD2:
with ActiveDrive DC motor, PWM, linear encoder, motor brake
- M-5x1.DG1:
with DC gear motor, rotary encoder
- M-5x1.EC:
with brushless DC motor, rotary encoder
- M-5x1.PD1:
with ActiveDrive DC motor, PWM, rotary encoder
- M-5x1.PG1:
with DC gear motor, PWM, rotary encoder
- M-5x1.2S1:
with 2-phase stepper motor

x stands for travel range:

1 = 102 mm

2 = 204 mm

3 = 306 mm



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Subject to change without notice. This manual is superseded by any new release. The latest release is available for download (p. 4) on our website.



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1 About this Document

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1.1 Goal and Target Audience of this User Manual

This manual contains information on the intended use of the M-5x1.

It assumes that the reader has a fundamental understanding of basic servo systems as well as motion control concepts and applicable safety procedures.

The latest versions of the user manuals are available for download (p. 4) on our website.

1.2 Symbols and Typographic Conventions

The following symbols and typographic conventions are used in this user manual:

CAUTION



Dangerous situation

If not avoided, the dangerous situation will result in minor injury.



- Actions to take to avoid the situation.



NOTICE**Dangerous situation**

If not avoided, the dangerous situation will result in damage to the equipment.

- Actions to take to avoid the situation.

INFORMATION

Information for easier handling, tricks, tips, etc.

Symbol / Label	Meaning
1. 2.	Action consisting of several steps whose sequential order must be observed
➤	Action consisting of one or several steps whose sequential order is irrelevant
■	List item
p. 5	Cross-reference to page 5
RS-232	Labeling of an operating element on the product (example: socket of the RS-232 interface)
 	Warning sign on the product which refers to detailed information in this manual.

1.3 Definition

Term	Explanation
Load capacity	Maximum load capacity in the vertical direction when the stage is mounted horizontally. The contact point of the load is in the center of the platform.
Max. push/pull force	Maximum force in the direction of motion. Some stages may have higher forces but with limited lifetimes. In the case of vertical mounting, the specified value (p. 57) for models without a gearhead and brake only applies when the servo mode is on.
Incremental position sensor	Sensor (encoder) for capturing changes of position or changes of angle. Signals from the incremental position sensor are used for axis position feedback. After switching on the controller a reference point definition must be performed before absolute target positions can be commanded and reached.

1.4 Figures

For better understandability, the colors, proportions and degree of detail in illustrations can deviate from the actual circumstances. Photographic illustrations may also differ and must not be seen as guaranteed properties.

1.5 Other Applicable Documents

The devices and software tools which are mentioned in this documentation are described in their own manuals.

Controller	Document
C-863.11 DC Motor Controller	MS205E User Manual
C-663.11 Stepper Motor Controller	MS208E User Manual
C-843 DC Motor Controller PCI Board	MS77E User Manual
C-884 DC Motor Controller	MS213E User Manual

1.6 Downloading Manuals

INFORMATION

If a manual is missing on our website or if there are problems in downloading:

- Contact our customer service department (p. 55).

The current versions of the manuals are found on our website. Access to the manuals of Hexapod systems and electronics whose scope of delivery includes a CD is password-protected. The password is stored on the CD.

Download freely accessible manuals

1. Open the website <http://www.pi-portal.ws>.
2. Click **Downloads**.
3. Click the corresponding category (e. g. **M Hexapods / Micropositioning**)
4. Click the corresponding product code (e. g. **M-5x1**).
5. Click **Documents**.

The available manuals are displayed.

6. Click the desired manual and save it on the hard disk of your PC or on a data storage medium.

Download password-protected manuals

1. Carry out steps 1 to 5 of the download process for freely accessible manuals.
2. Insert the product CD in the PC drive.
3. Switch to the **Manuals** directory on the CD.
4. In the **Manuals** directory, open the Release News (file including **releasenews** in the file name).
5. Find the user name and password in the **User login for software download** section in the Release News.
6. In the **User login** area on the left margin in the website, enter the user name and the password in the corresponding fields.
7. Click **Login**.

The available manuals are displayed.

8. Click the desired manual and save it on the hard disk of your PC or on a data storage medium.

2 Safety

In this Chapter

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2.1 Intended Use

The M-5x1 is a laboratory device as defined by DIN EN 61010. It is intended to be used in interior spaces and in an environment which is free of dirt, oil, and lubricants.

Based on its design and realization, the M-5x1 is intended for positioning, adjusting and shifting loads in one axis at various velocities. The M-5x1 is **not** intended for applications in the field of medical and food technology, industrial production or in other areas in which a failure would cause considerable risks to human beings or the environment.

The M-5x1 is intended for horizontal or vertical mounting. For the load limits with vertical mounting, see "General Notes on Installation" (p. 19).

The intended use of the M-5x1 is only possible in a completely assembled and connected state.

The M-5x1 must be operated with a suitable controller (p. 13). The controller is not included in the scope of delivery of the M-5x1.

2.2 General Safety Instructions

The M-5x1 is built according to state-of-the-art technology and recognized safety standards. Improper use can result in personal injury and/or damage to the M-5x1.

- Only use the M-5x1 for its intended purpose, and only use it if it is in a good working order.
- Read the user manual.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for the correct installation and operation of the M-5x1.

2.3 Organizational Measures

User manual

- Always keep this user manual available by the M-5x1.
The latest versions of the user manuals are available for download (p. 4) on our website.
- Add all information given by the manufacturer to the user manual, for example supplements or Technical Notes.
- If you pass the M-5x1 on to other users, also turn over this user manual as well as other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can result in minor injury and property damage.
- Only install and operate the M-5x1 after having read and understood this user manual.

Personnel qualification

The M-5x1 may only be installed, started up, operated, maintained and cleaned by authorized and appropriately qualified personnel.

3 Product Description

In this Chapter

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3.1 Model Overview

Classification of the stages

The stages of the M-511, M-521 and M-531 series are summarized under the designation M-5x1 in this manual.

All models are micropositioning stages with a ball screw. They differ in terms of:

- Travel range
- Drive type
- Presence of a motor brake
- Encoder type

M-5x1	Travel range in mm	Travel range in inches
x = 1	102	4
x = 2	204	8
x = 3	306	12

Version	Drive type					Brake present	Encoder type	
	DC motor				Stepper motor		Linear	Rotary
	Direct drive, PWM	Direct drive, brush-less, PWM	Gear-head, analog	Gear-head, PWM				
.DD1	●						●	
.DD2	●					●	●	
.PD1	●							●
.EC		●						●
.DG1			●					●
.PG1				●				●
.2S1					●			

Detailed model overview

Order Number	Product Name
M-511.2S1	Precision Translation Stage, 102 mm, 2-Phase Stepper Motor
M-511.DD1	Precision Translation Stage, 102 mm, DC Motor, PWM Control, Linear Encoder
M-511.DD2	Precision Translation Stage, 102 mm, DC Motor, PWM Control, Linear Encoder, Motor Brake
M-511.DG1	Precision Translation Stage, 102 mm, DC Gear Motor, Rotary Encoder
M-511.EC	Precision Translation Stage, 102 mm, Brushless DC Motor, Rotary Encoder
M-511.PD1	Precision Translation Stage, 102 mm, DC Motor, PWM Control, Rotary Encoder
M-511.PG1	Precision Translation Stage, 102 mm, ActiveDrive DC Gear Motor, Rotary Encoder
M-521.2S1	Precision Translation Stage, 204 mm, Stepper Motor
M-521.DD1	Precision Translation Stage, 204 mm, DC Motor, PWM Control, Linear Encoder
M-521.DD2	Precision Translation Stage, 204 mm, DC Motor, PWM Control, Linear Encoder, Motor Brake
M-521.DG1	Precision Translation Stage, 204 mm, DC Gear Motor, Rotary Encoder
M-521.EC	Precision Translation Stage, 204 mm, Brushless DC Motor, Rotary Encoder

Order Number	Product Name
M-521.PD1	Precision Translation Stage, 204 mm, DC Motor, PWM Control, Rotary Encoder
M-521.PG1	Precision Translation Stage, 204 mm, DC Gear Motor, PWM Control, Rotary Encoder
M-531.2S1	Precision Translation Stage, 306 mm, Stepper Motor
M-531.DD1	Precision Translation Stage, 306 mm, DC Motor, PWM Control, Linear Encoder
M-531.DD2	Precision Translation Stage, 306 mm, DC Motor, PWM Control, Linear Encoder, Motor Brake
M-531.DG1	Precision Translation Stage, 306 mm, DC Gear Motor, Rotary Encoder
M-531.EC	Precision Translation Stage, 306 mm, Brushless DC Motor, Rotary Encoder
M-531.PD1	Precision Translation Stage, 306 mm, DC Motor, PWM Control, Rotary Encoder
M-531.PG1	Precision Translation Stage, 306 mm, DC Gear Motor, PWM Control, Rotary Encoder

➤ For further technical data, see the specifications (p. 57).

3.2 Product View

3.2.1 Overview



Figure 1: Stages of the M-511, M-521 and M-531 series (from front to back)

3.2.2 Product Details

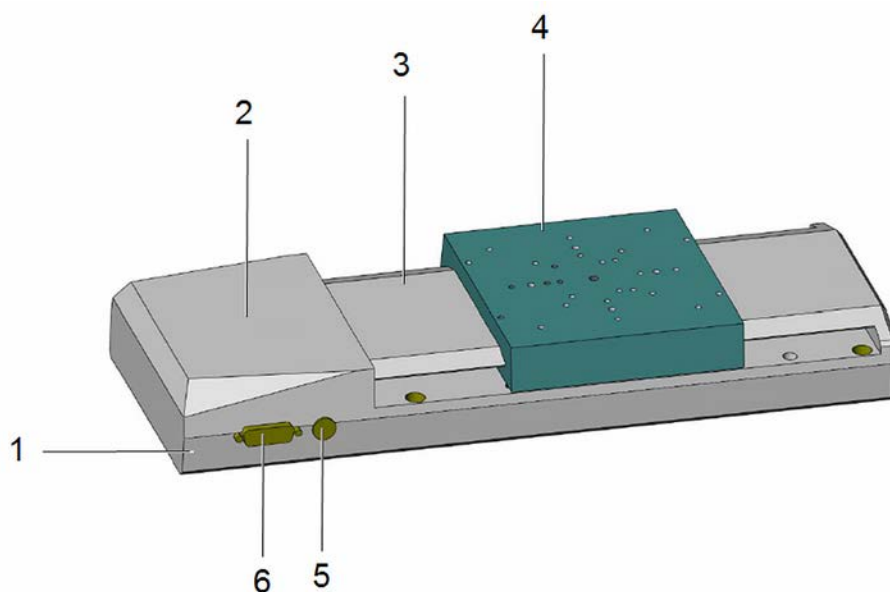


Figure 2: Components of the stage (colored; here: M-511)

- 1 Base body
- 2 Motor cover
- 3 Spindle cover
- 4 Moving platform
- 5 Power supply connection (M8 panel plug; not with the .DG1 and .2S1 models)
- 6 Controller connection (Sub-D 15 panel plug)

3.2.3 Product Labeling

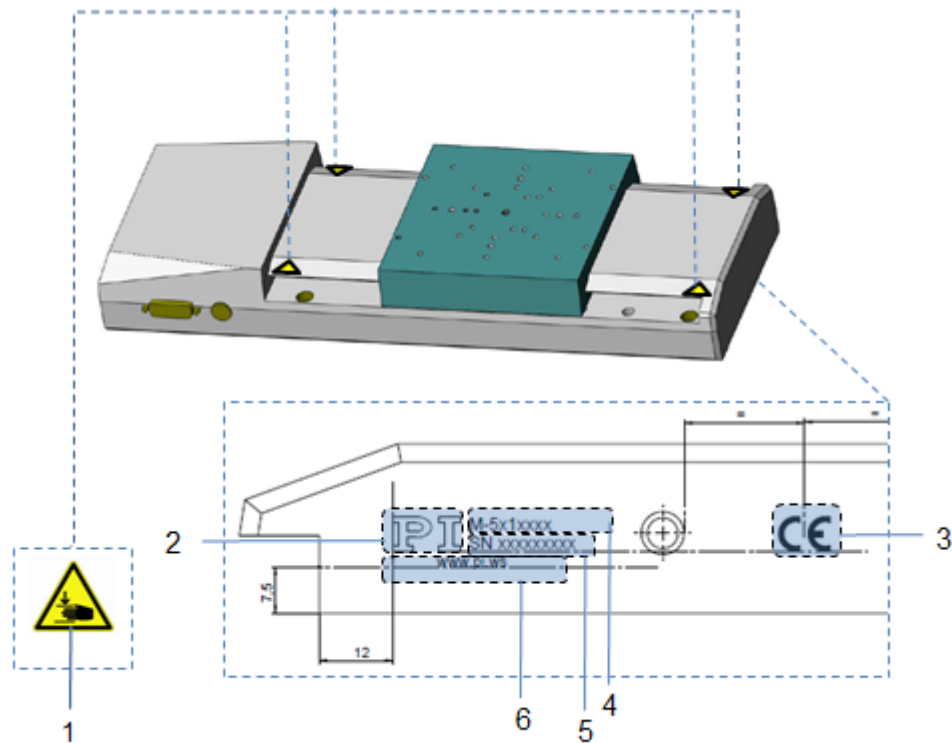


Figure 3: Product Labeling

- 1 "Risk of crushing" warning sign
- 2 Manufacturer's logo
- 3 CE conformity mark
- 4 Stage model
- 5 Serial number
- 6 Manufacturer's website

Position numbers 2 to 6 on the front side of the stage

3.3 Scope of Delivery

Item ID	Component
M-5x1.xxx	Stage according to order (p. 7)
2504	Screw set for attaching the stage, load and mounting adapters <ul style="list-style-type: none"> ▪ Four M4x16-A2 hex-head cap screws ISO 4762 ▪ Four M4x30-A2 hex-head cap screws ISO 4762 ▪ Four M6x30-A2 hex-head cap screws ISO 4762 ▪ Allen wrench AF 3 DIN 911 ▪ Allen wrench AF 5 DIN 911
C-815.38	Sub-D 15 motor cable (m/f), 3 m
MP113E	User manual (this document) in printed form
Only with the models M-5x1.DD1, .DD2, .EC, .PG1, .PD1	
C-663.PS	Wide-range-input power supply 24 V / 42 W
3763	Power cord
K050B0003	Adapter for the power supply connection; barrel connector to M8 4-pin connector

3.4 Accessories

Order Number	Description
C-815.83	Motor cable, 10 m, Sub-D, 15-pin (m/f)
M-500.206	Adapter plate for mounting H-206 Hexapods on M-511, M-521 and M-531 stages. Material: Al
M-590.00	Three-point support for mounting M-505, M-510, M-511, M-521 and M-531 stages on honeycomb tables etc. (metric and inches). Material: Al; mass: 0.4 kg Consisting of: <ul style="list-style-type: none"> ▪ Adapter plate, wide (M59000001) ▪ Adapter plate, narrow (M59000002)
M-592.10	Adapter bracket for vertical mounting of M-511, M-521 and M-531 stages. Material: Al; mass: 1.5 kg

To order, contact our customer service department (p. 55).

3.5 Suitable Controllers

The M-5x1 must be connected to a suitable controller. The following controllers from PI are suitable for the operation of the M-5x1:

Drive type	Controller	Axes per controller	PC interface	Multiple controllers on the same PC
DC motor	C-843	2 or 4	Internal (PCI bus)	Yes, separate boards
	C-863	1	USB, RS-232, daisy chain	Yes, same interface
	C-884	1 to 4	USB, RS-232, TCP/IP	Yes
Stepper motor	C-663	1	USB, RS-232, daisy chain	Yes, same interface

PC software is included in the scope of delivery of controllers from PI. The operation of the controllers is described in the corresponding user manuals.

3.6 Technical Features

3.6.1 Encoder

Linear encoder

The M-5x1.DD1 and .DD2 models are equipped with an optical linear encoder. For the encoder resolution, refer to the table in the "Specifications" section (p. 57).

Optical linear encoders measure the actual position directly (direct metrology). Therefore, errors occurring in the drive, such as nonlinearity, backlash or elastic deformations cannot influence the measurement of the position.

Rotary encoder

The M-5x1.PD1, .PG1, .DG1 and .EC models are equipped with an incremental rotary encoder.

A rotary encoder is implemented at a rotating point in the drivetrain, e.g. the motor shaft.

3.6.2 Limit Switches

The M-5x1 is equipped with noncontact, Hall-effect limit switches. The signals of the limit switches are used to stop the moving platform before the hard stop at both ends of the travel range.

Limit switch function with the M-5x1:

Limit switch*	Availability of the signal	Function
"Inner" limit switches N1 and P1	Output to the controller on the Sub-D 15 panel plug (p. 67) See also "Limit Switch Specifications" (p. 60).	When triggering takes place, the controller switches off the servo mode for the affected axis and thereby stops the motion. The moving platform can be moved away from the limit switch by command, see "Possible Causes and Correction" (p. 49).

Limit switch*	Availability of the signal	Function
"Outer" limit switches N2 and P2	No connection to the controller	The triggering interrupts the power source of the drive via a relay. The moving platform cannot be moved away from the limit switch by command but must be moved manually (p. 52).

*N = negative limit switch, P = positive limit switch

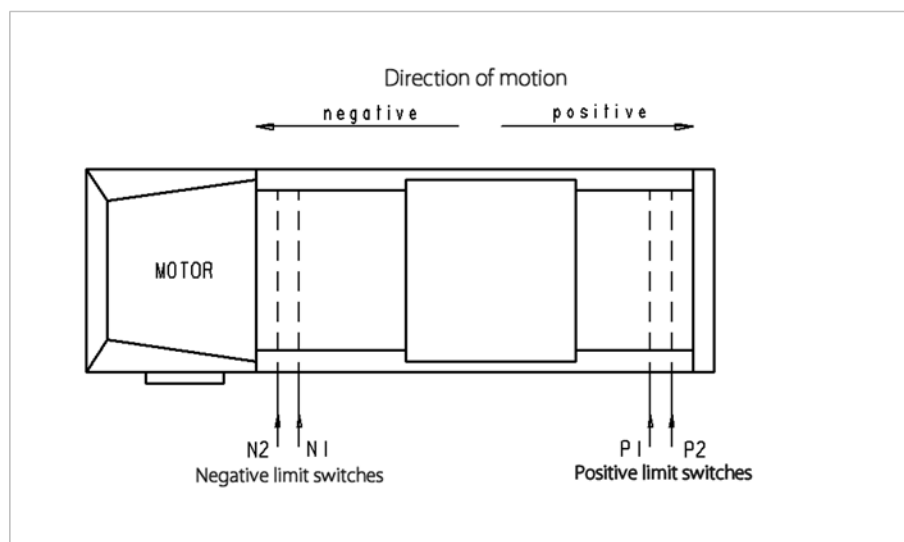


Figure 4: Limit switch arrangement with the M-5x1

The distance between N1 and N2 or P1 and P2 is approx. 5.3 mm in each case.

INFORMATION

In the case of controllers from PI, the permissible travel range of the stage is represented by parameters in the controller. Suitable parameter values can be loaded from a stage database in the supplied PC software (see also "M-5x1 Entries in the Stage Database of PI" (p. 45)). The values for the lower and upper limit of the travel range are selected in the stage database so that the limit switches **cannot** be approached with motion commands. The controller furthermore calculates the dynamic profile during the motion so that the stage brakes in time before the end of the permissible travel range. The stage can only reach the limit switch in exceptional cases, e.g. with a very high velocity and/or under high load.

For details, see the user manual of the controller.

3.6.3 Reference Point Switch

The stage is equipped with a direction-sensing reference point switch that is located approximately in the middle of the travel range. This sensor transmits a TTL signal that indicates whether the stage is on the positive or negative side of the reference point switch.

The commands that use the reference signal are described in the user manual of the controller and/or in the corresponding software manuals.

3.6.4 Motor Brake

The M-5x1.DD2 models are equipped with a motor brake. Stages with a motor brake are especially suited for vertical mounting.

The motor brake is activated and deactivated via the connected controller. Controllers from PI activate the brake automatically when the servo mode is switched off. For details, see the user manual of the controller.

3.6.5 Brushless Motor

The M-5x1.EC models are equipped with a brushless DC motor. The motor is electronically commuted and thus very low-wear.

3.6.6 Integrated PWM Amplifier

The M-5x1.DD1, .DD2, .PD1 and .EC models with direct drive are equipped with a PWM amplifier ("ActiveDrive concept"). The motor and PWM amplifier are installed in a common case and thus optimally integrated and shielded. The PWM amplifier only receives the control signals from the controller, whereas the supply voltage is provided via an external power supply. The ActiveDrive concept allows a high motor power and dynamics with a low loss of power.

The M-5x1.PG1 models with DC gear motor are only equipped with a PWM amplifier for compatibility reasons.

4 Unpacking

1. Unpack the M-5x1 with care.
2. Compare the contents against the items covered by the contract and against the packing list.
3. Inspect the contents for signs of damage. If parts are missing or you notice signs of damage, contact PI immediately.
4. Keep all packaging materials in case the product needs to be returned.

5 Installation

In this Chapter

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Affixing the Load to the M-5x1	27
Setting Up a Multi-Axis System	29
Connecting the Motor Cable to the M-5x1	39
Connecting the Power Supply to the M-5x1	39

5.1 General Notes on Installation

NOTICE



Unintentional changes in position with vertical mounting!

If the load exceeds the self-locking of the drive when the stage is mounted vertically, unintentional changes in the position of the moving platform occur. Unintentional changes in position of the moving platform can damage the drive, the load or the environment.

- When a stage is installed vertically, make sure that the installed load is lower than the self-locking of the drive:
 - Stage with direct drive and stepper motor: max. 10 N
 - Stage with gearhead: max. 80 N
 - Stage with motor brake: max. 80 N
- In the case of vertical mounting, use a stage with a motor brake (.DD2) or with a gearhead (.DG1, .PG1).

NOTICE



Protruding screw heads!

Protruding screw heads can damage the M-5x1.

- Ensure that the screw heads do not protrude from counter-sunk holes so that they do not interfere with the stage motion.

NOTICE**Cable break!**

A cable break leads to a failure of the stage.

- Install the stage so that the cable is not bent or squeezed too severely during operation.

NOTICE**Heating up of the M-5x1 during operation!**

The heat produced during operation of the M-5x1 can affect your application.

- Install the M-5x1 so that your application is not affected by the dissipating heat.

INFORMATION

For optimum repeatability, all components must be affixed without backlash.

- Make sure that the stage, load and - if present - the mounting adapter are affixed without backlash.

INFORMATION

Models with DC gear motors are equipped with integrated signal drivers for cable lengths ≤ 10 m between the stage and the motor controller.

INFORMATION

The holes in the moving platform of the M-5x1 are arranged in the PI standard hole pattern. The PI standard hole pattern is used with many micropositioning stages from PI and allows a simple combination of linear and rotation stages with minimum effort.

- If possible, carry out a simulation of the stage motions with a mounted load or suitable calculations in order to identify collisions or unfavorable center of gravity constellations.
- If necessary, take suitable constructive measures to avoid collisions and instabilities in the overall system.
- Avoid or mark danger zones that result from the installation of the stage and the application, in accordance with the legal regulations.

5.2 Attaching the M-5x1 to a Surface

INFORMATION

The positive direction of motion is away from the cable exit side.

5.2.1 Using a Surface with the Hole Pattern of the M-5x1 Base Body

NOTICE



Warping of the M-5x1 due to mounting on uneven surfaces!

Mounting the M-5x1 on an uneven surface can warp the M-5x1. Warping reduces the accuracy.

- Mount the M-5x1 on an even surface. The recommended evenness of the surface is $\leq 10 \mu\text{m}$.
- For applications with great temperature changes:
Only mount the M-5x1 on surfaces that have the same or similar thermal expansion properties as the M-5x1.

NOTICE



Wear from manually moving the moving platform!

Manually moving the moving platform increases wear in the case of stages with a gearhead.

- With the M-5x1.DG1 and .PG1 models, only move the platform manually if there is no other possibility for motion.

INFORMATION

The M-5x1 can be attached to a surface with M6 screws or M4 screws. Advantages when the stage is installed with M6 screws:

- The holes for M6 screws are freely accessible in the delivery state.
- M6 screws can absorb greater forces than M4 screws.

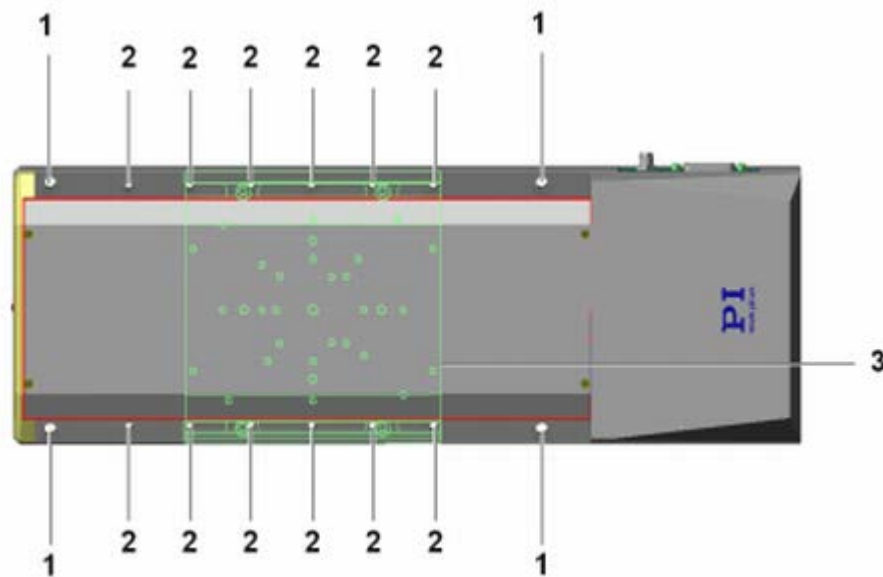


Figure 5: Mounting holes in the base body of the stage

- 1 Mounting hole with counterbore for M6 hex-head cap screw
- 2 Mounting hole with counterbore for M4 hex-head cap screw
- 3 Moving platform in delivery state (implied)

Prerequisites

- ✓ You have read and understood the general notes on installation (p. 19).
- ✓ You have provided a suitable surface (for the required position and depth of the holes for accommodating the screws, see "Dimensions" (p. 61)):
 - Four mounting holes are present. Optimum: M6 holes, alternatively: M4 holes
 - The evenness of the surface is $\leq 10 \mu\text{m}$.
 - For applications with great temperature changes: The surface should have the same thermal expansion properties as the M-5x1 (e.g. surface made of aluminum).
- ✓ You accounted for the space required for cable routing free of kinks and in accordance with regulations.
- ✓ If you want to make the mounting holes in the base body of the M-5x1 accessible by manually moving the moving platform: The stage is **not** connected to the power supply and the controller.

Tools and accessories

- Screws, in the scope of delivery:
 - 4 × M6x30or
 - 4 × M4x30
- Suitable screwdriver, in the scope of delivery:
 - For M6 screws: Allen wrench AF 5
 - For M4 screws: Allen wrench AF 3

Attaching the stage to a surface with the hole pattern of the M-5x1

1. Align the stage on the surface so that the corresponding mounting holes in the stage and surface overlap.

If you use M4 screws, make the mounting holes in the base body of the stage accessible. Possible measures:

- Temporary start-up of the stage (p. 41) and commanding the platform to a suitable position
 - Manually moving the moving platform (p. 52)
2. Completely screw the screws into all mounting holes.
 3. Check that the stage fits on the surface without backlash.

5.2.2 Using Adapters for the 25 mm x 25 mm Hole Pattern

INFORMATION

An adapter is necessary to attach the M-5x1 to a commercially available honeycomb plate with a hole pattern of 25 mm x 25 mm and M6 screws. PI offers the M-590.00 two-part three-point support as an adapter, see "Accessories" (p. 13).

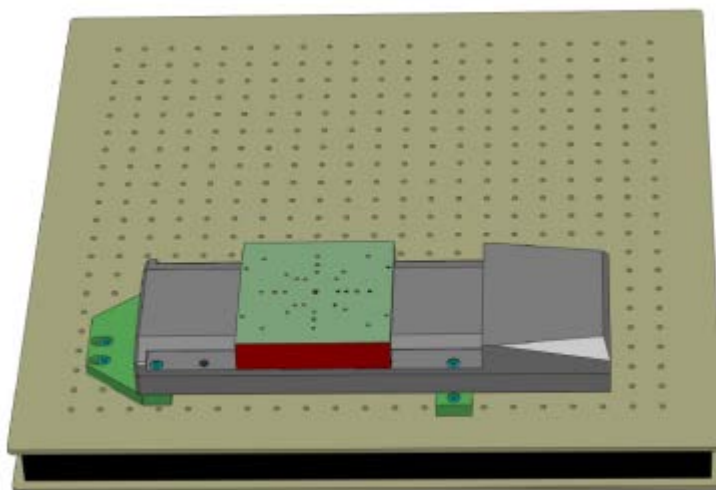


Figure 6: M-5x1 with adapter (M-590.00 three-point support) on a honeycomb plate

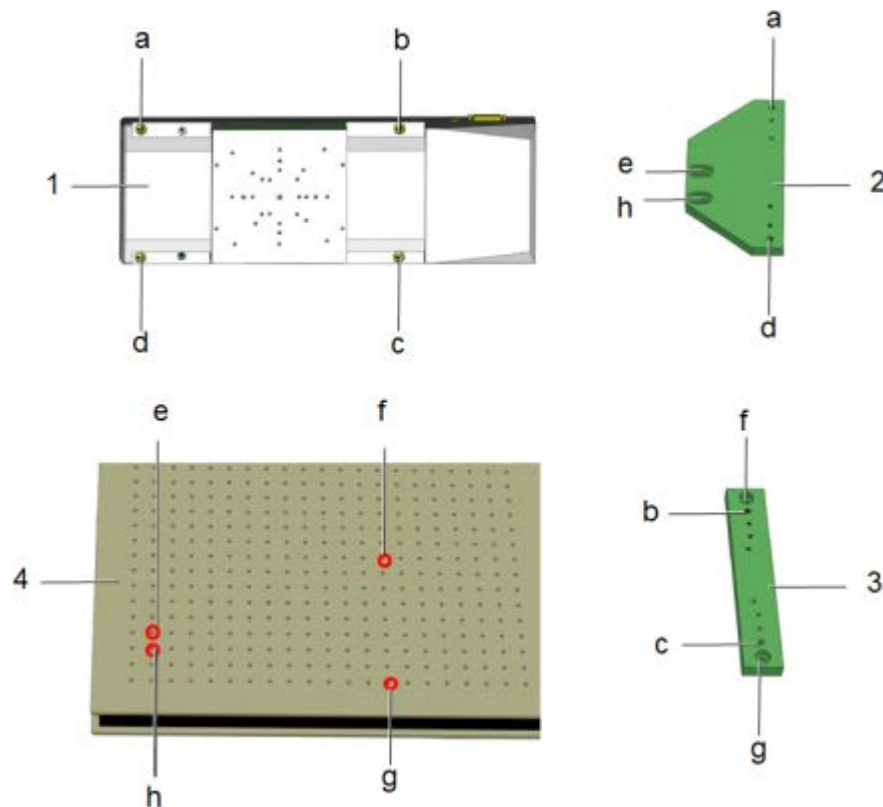


Figure 7: Individual components to be connected with relevant holes

- 1 Stage (here M-511)
- 2 Wide adapter plate, part of the M-590.00 three-point support
- 3 Narrow adapter plate, part of the M-590.00 three-point support
- 4 Honeycomb plate with 25 mm x 25 mm hole pattern (used holes emphasized)
- a to h Holes for M6 screws.
- Screws that overlap during attachment are designated with the same letters.

Prerequisites

- ✓ You have read and understood the General Notes on Installation (p. 19).
- ✓ You have taken into account the space requirements for a kink-free and correct cable routing.

Tools and accessories

- M-590.00 three-point support, two-part, available as an optional accessory (p 13).
- For attaching the M-590.00 three-point support to the M-5x1:
 - Four M6x30 screws, in the scope of delivery
 - Allen wrench AF 5, in the scope of delivery
- For attaching the M-590.00 three-point support to the honeycomb plate:
 - Four M6 screws of suitable length (not in the scope of delivery), see "M-590.00 Three-Point Support, Two-Part" (p. 65) for the dimensions.
 - Suitable tools for fastening the screws

Attaching the stage to a honeycomb plate

1. Attach the two parts of the M-590.00 three-point support to the M-5x1:
 - a) Place the two adapter plates on the honeycomb plate or on another even, clean and safe surface.
 - b) Align the two adapter plates on the surface approximately in the position of the mounting holes **a** to **d** in the base body of the stage (see the figure of the individual parts to be connected).
 - c) Place the stage on the two adapter plates so that the holes **a** to **d** each approximately overlap.
 - d) Align the two adapter plates so that the holes **a** to **d** each precisely overlap.
 - e) Completely screw in M6x30 screw into each of the holes **a** to **d** of the stage.
2. Attach the two parts of the M-590.00 three-point support to the honeycomb plate:
 - a) Place the stage to which the two adapter plates are attached on the honeycomb plate.
 - b) Align the stage so that the holes **e** to **h** in the honeycomb plate and the three-point support each overlap (see figure of the individual parts to be connected).
 - c) Completely screw an M6 screw into each of the holes **e** to **h** of the three-point support.
3. Check that the stage fits on the honeycomb without backlash.

5.3 Affixing the Load to the M-5x1

NOTICE



Impermissibly high load on the stage!

An impermissible high load interferes with the motion of the moving platform and can damage the stage.

- In respect to the mass and mounting type of the load, observe the maximum permissible forces that are allowed to act on the moving platform according to the specification (p. 57).

NOTICE



Screws that are too long!

Screws that are inserted too deeply can damage the M-5x1.

- Observe the depth of the mounting holes in the moving platform (p. 62).
- Only use screws of the correct length for the respective mounting holes.

Prerequisites

- ✓ You have read and understood the general notes on installation (p. 19).
- ✓ You have properly attached the stage to a surface (p. 21).
- ✓ The stage is **not** connected to the power supply and the controller.
- ✓ You prepared the load so that it can be affixed to the mounting holes on the moving platform:
 - The distance between the center of gravity of the load and the center of the moving platform is as small as possible in all directions.
 - At least two points are provided for affixing the load to the moving platform (ideally: three or four attachment points).
 - If you use locating pins to align the load: You have made two to four locating holes in the load with Ø 4 mm and a suitable tolerance for accommodating locating pins.

Tools and accessories

- Suitably long screws. Options:
 - At least two M4 screws
 - One M6 screw and at least one M4 screw

- Suitable tools for fastening the screws
- Optional: 2 to 4 locating pins for easy alignment of the load on the M-5x1, suitable for holes with \varnothing 4 mm; for tolerance data, see figure of the holes in the moving platform; locating pins not in the scope of delivery

Affixing the load to the M-5x1

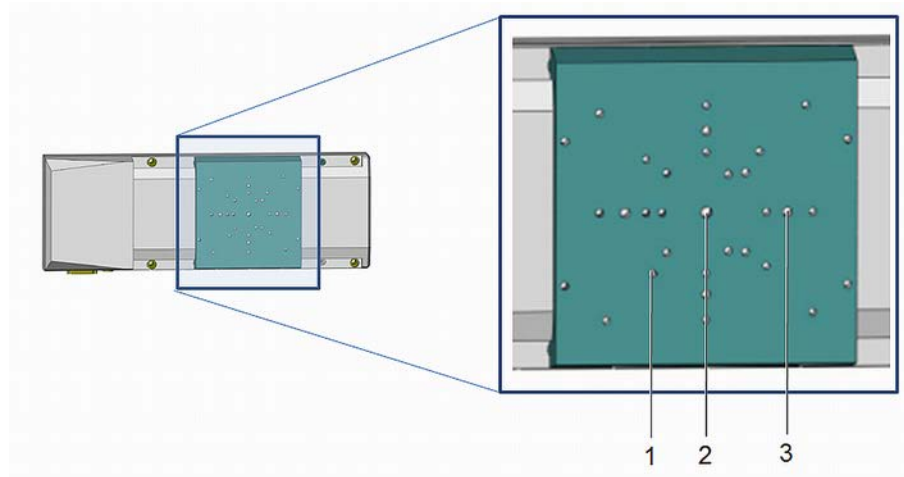


Figure 8: Holes in the moving platform of the M-5x1

- 1 M4 mounting hole, depth 8 mm (total of 27)
- 2 Central M6 mounting hole, depth 8 mm
- 3 Locating hole \varnothing 4 mm H7, depth 5 mm (total of 4)

1. Align the load so that the selected mounting holes in the moving platform can be used for affixing it.

If you use locating pins to align the load:

- a) Insert the locating pins into the locating holes in the moving platform or the load.
- b) Place the load on the moving platform in such a way that the locating pins are inserted into the corresponding locating holes on the other side.

The arrangement of the mounting and locating holes in the moving platform of the M-5x1 as well as the tolerance data can be found in the corresponding figure as well as in the dimensional drawing (p. 62).

2. Affix the load to the selected mounting holes in the moving platform using the screws.
3. Check that the load fits on the moving platform of the stage without backlash.

5.4 Setting Up a Multi-Axis System

The M-5x1 can be used in multi-axis systems.

Typical combinations:

- XY system (p. 31)
- Z system (p. 33) (XZ or XYZ combination)
- For combination possibilities with other stages, contact our customer service department (p. 55).

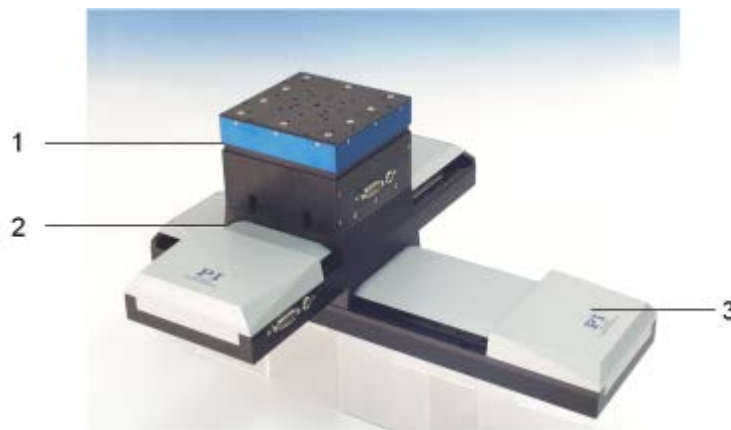


Figure 9: Example of an XYZ system: two M-511.DD1 stages / one M-501.1PD Z stage

- 1 M-501.PD Z stage, directly mounted
- 2 Upper stage (here: M-511.DD1), directly mounted
- 3 Lower stage (here: M-511.DD1)

5.4.1 General Information on Setting Up a Multi-Axis System

NOTICE

**Impermissibly high load on the stages!**

In a multi-axis system, also the stage used for the Y and/or Z axis must be moved. Impermissibly high loads interfere with the motion and can damage the stages.

- Include the masses of the moved stages and the mounting adapters (p. 13) in the calculation of the load to be moved.
- For all stages in a multi-axis system: Do **not** exceed the maximum permissible load.
- When a stage is installed vertically, make sure that the installed load is lower than the self-locking of the drive.

NOTICE

**Wear from manually moving the moving platform!**

Manually moving the moving platform increases wear in the case of stages with a gearhead.

- With the M-5x1.DG1 and .PG1 models, only move the platform manually if there is no other possibility for motion.
- Only install and operate the multi-axis system after you have read and understood the user manuals of all components of the multi-axis system.
- If you require special mounting adapters, contact our customer service department (p. 55).

5.4.2 Setting Up an XY System

NOTICE



Screws that are too long!

Screws that are inserted too deeply can damage the lower stage.

- Observe the depth of the mounting holes in the moving platform of the lower stage.
- Only use screws of the correct length for the respective mounting holes.

Designations in these instructions:

- **Lower stage:** Forms the basis of the multi-axis system (X-axis), is attached to a surface
- **Upper stage:** Forms the Y-axis of the multi-axis system, is attached to the lower stage rotated by 90°

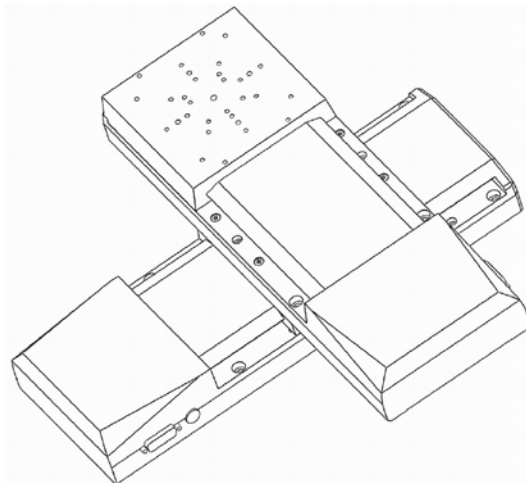


Figure 10: Example: XY system consisting of two M-511 stages

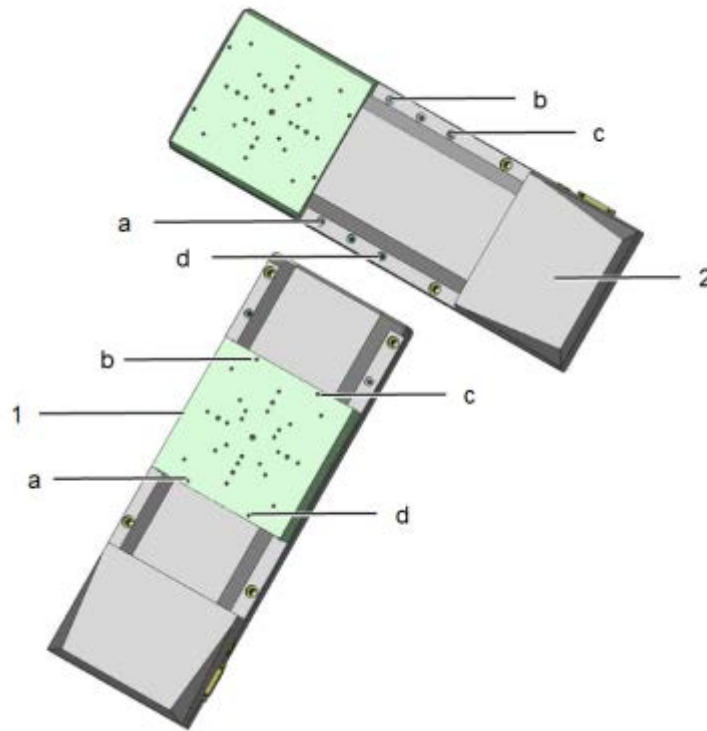


Figure 11: Example: Setting up an XY system consisting of two M-511 stages

- 1 Lower stage with
a - d) M4 mounting holes in the platform
 - 2 Upper stage (moving platform on the positive end of the travel range)
with
a - d) mounting holes with counterbore for M4 hex-head cap screws, in
the base body of the stage
- Holes that overlap during attachment are marked with the same letters.

Prerequisites

- ✓ You have read and understood the General Notes on Installation (p. 19).
- ✓ You have read and understood the general notes on setting up a multi-axis system (p. 30).
- ✓ You accounted for the space required for cable routing free of kinks and in accordance with regulations.
- ✓ The used stages are disconnected from the power supply and controller.
- ✓ You have properly attached the lower stage to a surface (p. 21).

Tools and accessories

- Four M4 screws of suitable length from the scope of delivery of the upper stage
 - When an M-5x1 is attached to an M-5x1 as in the figure above: Four M4x30 screws
- Allen wrench AF 3, in the scope of delivery of the stages

Setting up an XY system

1. If necessary: Make the required mounting holes in the base body of the upper stage accessible. Possible measures:
 - Temporary start-up of the upper stage (p. 41) and commanding the platform to a suitable position
 - Manually moving the moving platform of the upper stage (p. 52)
2. Position the upper stage rotated by 90° on the moving platform of the lower stage (see above figure).
3. Align the upper stage so that the required mounting holes in the upper and lower stage overlap (holes **a** to **d** in the above figure).
4. Completely screw in M4 screw into each of the holes.
5. Check that the upper stage fits without backlash.

5.4.3 Setting Up a Z System with an Adapter Bracket

NOTICE



Screws that are too long!

Screws that are inserted too deeply can damage the lower stage.

- Observe the depth of the mounting holes in the moving platform of the lower stage.
- Only use screws of the correct length for the respective mounting holes.

INFORMATION

- If you use a Z stage for the Z axis (e.g. M-501.PD), follow the instructions in "Setting Up an XY System" (p. 31) for setting up the multi-axis system.

Designations in these instructions:

- **Lower stage:** X axis in an XZ combination; Y axis in an XYZ combination. The stage to which the upper stage is attached with an adapter bracket.
- **Upper stage:** Forms the Z-axis of the multi-axis system, is attached in a vertical alignment to the lower stage with an adapter bracket.

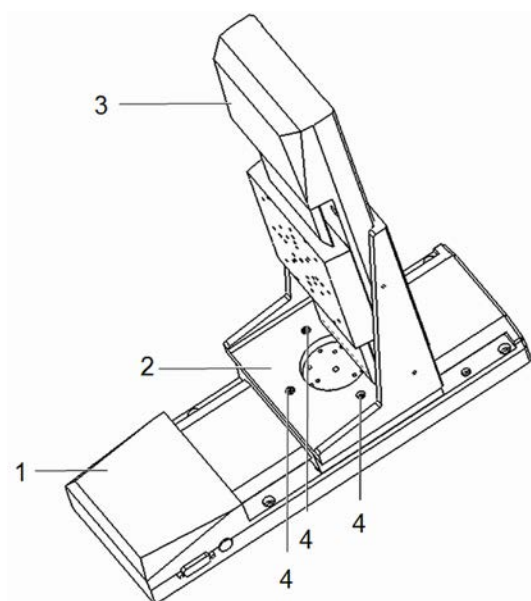


Figure 12: Example: XY combination consisting of two M-511 stages

- 1 Lower stage
- 2 M-592.10 adapter bracket
- 3 Upper stage
- 4 M4 screw

Prerequisites

- ✓ You have read and understood the General Notes on Installation (p. 19).
- ✓ You have read and understood the general notes on setting up a multi-axis system (p. 30).
- ✓ You accounted for the space required for cable routing free of kinks and in accordance with regulations.
- ✓ The used stages are disconnected from the power supply and controller.
- ✓ If you set up an XZ combination: You have properly attached the lower stage to a surface (p. 21).
- ✓ If you set up an XYZ combination: You have properly attached the stages for the X and Y axis (p. 31).

Tools and accessories

- Suitable adapter bracket, available as an optional accessory (p. 13):
 - M-592.10 when an M-5x1 stage is used as Z axis
- For attaching the Z axis to the adapter bracket: Four M4 screws of suitable length from the scope of delivery of the upper stage
 - When an M-5x1 is used as Z axis as in the figure above: Four M4x30 screws
- For attaching the adapter bracket to the lower stage: Four M4 screws of suitable length from the scope of delivery of the lower stage
 - When the M-592.10 adapter bracket is attached to an M-5x1: three M4x16 screws
- Allen wrench AF 3, in the scope of delivery of the stage

Setting up a Z system

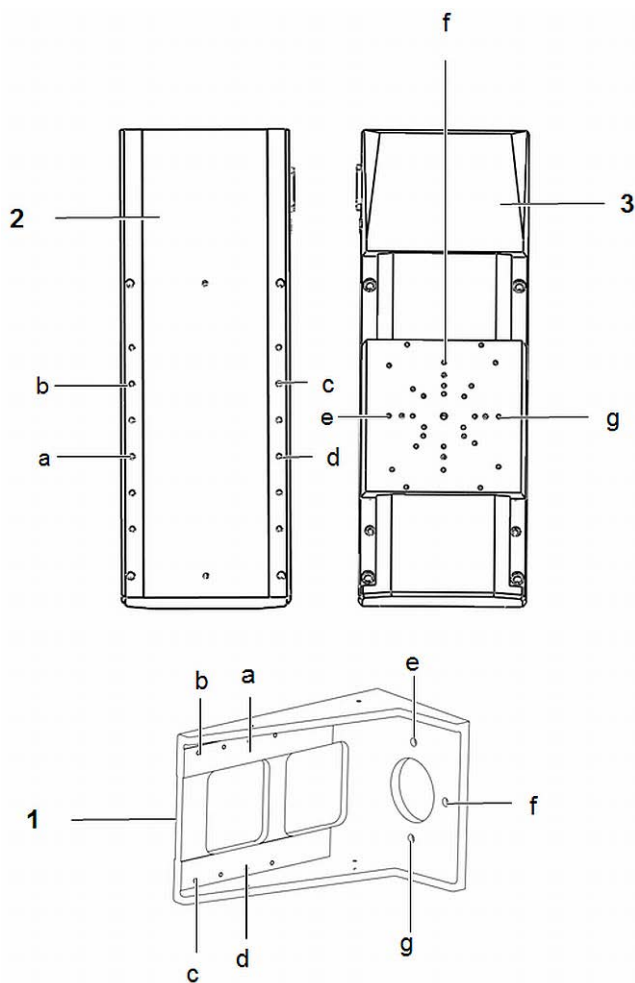


Figure 13: Example: Setting up an XY combination of two M-511 stages

1 M-592.10 adapter bracket

2 Upper stage (view of bottom side)

3 Lower stage

a-f: mounting holes:

Holes that overlap during attachment are marked with the same letter

1. If necessary: Make the required mounting holes in the base body of the upper stage accessible. Possible measures:
 - Temporary start-up of the upper stage (p. 41) and commanding the platform to a suitable position
 - Manually moving the moving platform (p. 52)
2. Attach the upper stage to the adapter bracket.

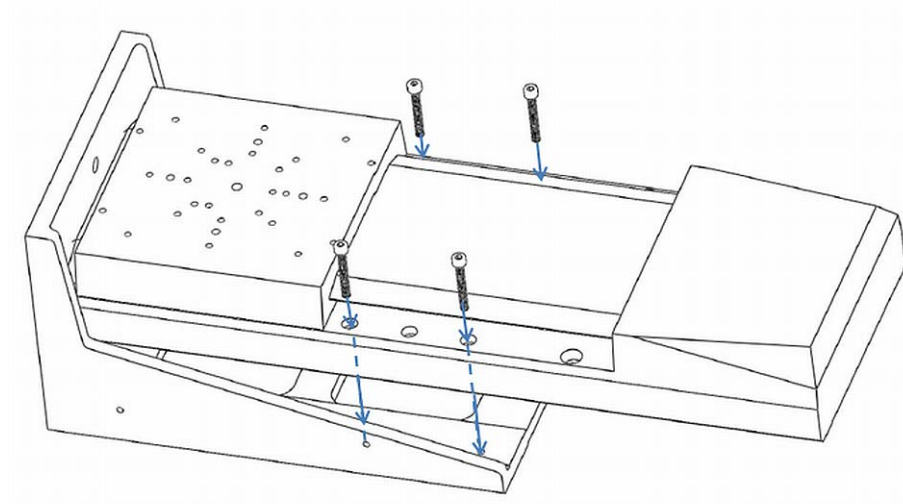


Figure 14: Attaching the upper stage to the adapter bracket

- a) Position the upper stage on the long surface of the adapter bracket as in the figure:
 - The stage lies on the inside of the bracket.
 - The motor cover of the stage faces the open end of the inside of the bracket (i.e. upwards in the Z system).
 - The required mounting holes in the stage and the bracket overlap (holes **a** to **d** in the above example).
- b) Completely screw in one M4 screw into each of the holes.

3. Attach the adapter bracket to the lower stage.

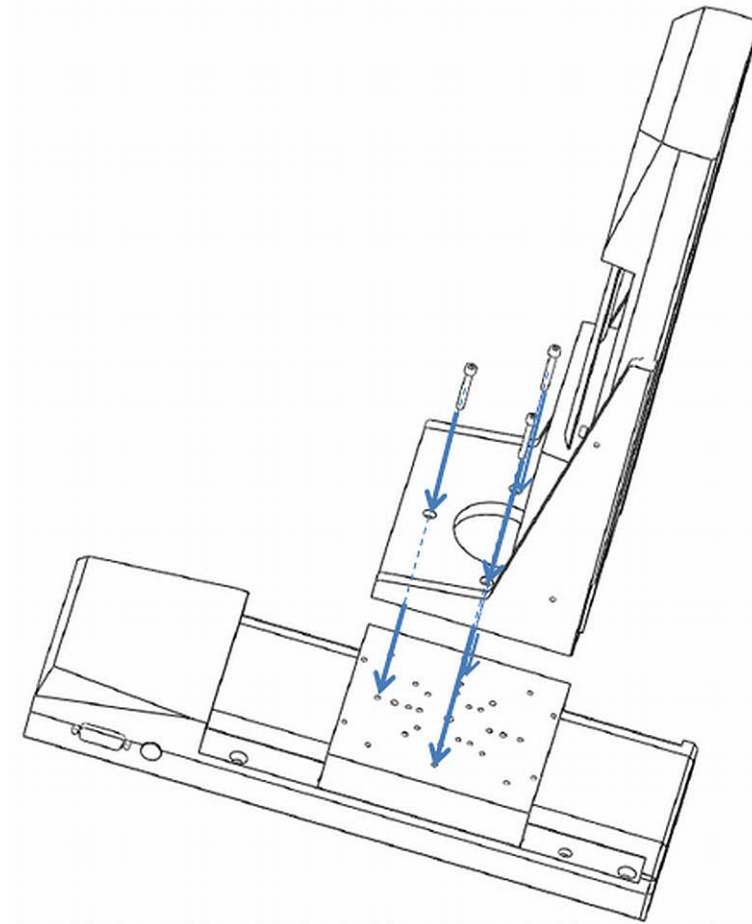


Figure 15: Attaching the adapter bracket to the lower stage

- a) Position the adapter bracket on which the upper stage is attached as in the figure to the moving platform of the lower stage.
 - The open end of the short side of the bracket faces the motor cover of the lower stage.
 - The required mounting holes in the bracket and the lower stage overlap (holes **e** to **g** in the above example).
 - b) Completely screw in one M4 screw into each of the holes.
4. Check that the adapter bracket and the upper stage fit without backlash.

5.5 Connecting the Motor Cable to the M-5x1

Prerequisites

- ✓ You have read and understood the general notes on installation (p. 19).
- ✓ The motor cable is not connected to the controller.

Tools and accessories

- Suitable motor cable from PI, e.g.:
 - Motor cable C-815.38, 3 m, Sub-D, 15-pin (m/f), in the scope of delivery (p. 12).
 - C-815.83 motor cable, 10 m, Sub-D, 15-pin (m/f), available as optional accessory (p. 13).

Connecting the motor cable to the M-5x1

1. Connect the connector (f) of the motor cable to the Sub-D 15-pin panel plug (m) of the stage.
2. Secure the connector (f) with the two integrated screws against being unintentionally pulled out of the stage.

5.6 Connecting the Power Supply to the M-5x1

Connecting a power supply is only necessary with the models M-5x1.DD1, .DD2, .EC, .PG1 and .PD1.

Prerequisites

- ✓ The power cord is **not** connected to the power socket.

Tools and accessories

- The included 24 V wide-range-input power supply (for line voltages between 100 and 240 VAC at 50 or 60 Hz)
- Alternatively: Sufficiently dimensioned power supply that provides 24 VDC with a maximum of 2.0 ampere
- Supplied adapter for the power supply connector; barrel connector to M8 4-pin connector (f)
- Alternatively: Sufficiently dimensioned adapter
- Included power cord
- Alternatively: Sufficiently dimensioned power cord

Connecting the power supply to the M-5x1

- Connect the M8 connector of the adapter with the M8 panel plug of the M-5x1.
- Connect the barrel connector of the adapter to the barrel connector socket of the power supply.
- Connect the power cord to the power supply.

6 Start-Up

In this Chapter

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6.1 General Notes on Start-Up

CAUTION



Risk of crushing by moving parts!

There is a risk of slight injuries from crushing between the movable parts of the stage or the load and a fixed part or obstacle.

- Use protective structures to keep limbs away from areas in which they could be seized by moving parts.
- Observe the safety distances in accordance with DIN EN ISO 13857 when installing protective structures.

NOTICE



Damage from collisions!

Collisions can damage the stage, the load to be moved and the environment.

- Make sure that no collisions are possible between the stage, the load to be moved and the environment in the motion range of the stage.
- Do not place any objects in areas where they can get caught by moving parts.
- Stop the motion immediately if a controller malfunction occurs.
- If possible, adapt the travel range limits of your mechanical system in the software that you use for commanding the motion.

NOTICE**Damage if an incorrect controller is connected!**

Connecting a stage to an unsuitable controller can cause damage to the stage or controller.

- Connect a stage with DC motor to a DC motor controller only.
- Connect a stage with stepper motor to a stepper motor controller only.
- If you use controllers and software from other manufacturers, check their technical data to make sure that they are suitable before starting up the stage!

NOTICE**Operating voltage too high or incorrectly connected!**

Operating voltages that are too high or incorrectly connected can cause damage to the M-5x1.

- Do **not** exceed the operating voltage range (p. 59) for which the M-5x1 is specified.
- Only operate the M-5x1 when the operating voltage is properly connected; see "Pin Assignment" (p. 67).

NOTICE**Damage or considerable wear from high accelerations!**

High accelerations can cause damage to or considerable wear on the mechanical system.

- Stop the motion immediately if a controller malfunction occurs.
- Ensure that the end of the travel range is approached at low velocity.
- Determine the maximum velocity for your application.

NOTICE**Unintentional motions after brake deactivated!**

In the case of stages with a motor brake: The deactivation of the brake can cause unintentional motions of the stage.

- Secure the stage against unintentional motions before you deactivate the brake by command!

INFORMATION

The maximum velocity for a stage with a stepper motor should be determined in the application. If the commanded velocity is too high, the stepper motor might stop without the controller detecting this condition.

INFORMATION

The repeatability of the positioning is only ensured when the reference point switch is always approached from the same side. Controllers from PI fulfill this requirement as a result of the automatic direction sensing for reference moves to the reference switch.

INFORMATION

For models with DC motors:

Unsuitable settings made to the servo-control parameters can impair the performance of the M-5x1. The consequences of this can be expressed as follows:

- Oscillations
- Imprecise approach of the position
- Settling time is too long
- If the performance of the M-5x1 is not satisfactory, check the settings for the servo-control parameters of your controller.

6.2 Starting up the Stage

Prerequisites

- ✓ You have read and understood the General Notes on Start-Up (p. 41).
- ✓ For starting up with a load or in a multi-axis system: You have properly installed the stage (p. 29).
- ✓ You have read and understood the user manual of the used controller.
- ✓ You have read and understood the manual of the used PC software.
- ✓ The controller and the required PC software have been installed. All connections on the controller have been set up (see user manual of the controller; the stage is connected via the motor cable).

Starting up the stage

1. Models M-5x1.DD1, .DD2, .PD1, .PG1 and .EC only: Connect the power cord of the power supply with the power socket.
2. Start up the controller (see user manual of the controller).
Configure the controller during the start-up using the PC software for the used stage (see user manual of the controller and of the PC software):
 - If you use a controller from PI: Select the entry in the stage database that precisely fits the used stage model (p. 45).
 - If you use a controller from another manufacturer: Enter the parameters that precisely fit the used stage model in the corresponding PC software; see the overview of the operating parameters for DC motor controllers (p. 45) or stepper motor controllers (p. 46).
3. Start a few motion cycles for testing purposes (see user manual of the controller).

6.2.1 M-5x1 Entries in the Stage Database of PI

For PI controllers, you can select the connected stage from a stage database in the corresponding PC software. The appropriate operating parameters are thus loaded to the controller. You can find a detailed description in the user manual for the controller or in the manual for the PC software used.

6.2.2 Operating Parameters of the Models with DC Motor

If you use a DC motor controller from a third-party supplier, it may be necessary to enter operating parameters to adjust the used stage.

Parameter	M-5x1 model				Unit
	.DD1, .DD2	.DG1, .PG1	.PD1	.EC	
P-Term	150	120	56	35	-
I-Term	90	180	23	10	-
D-Term	350	120	18	20	-
I-Limit	2000	2000	2000	2000	-
Maximum acceleration	40000000	2648886	1638400	250000	counts/s ²
Maximum velocity	50	6	100	125	mm/s
Maximum velocity	2500000	198666	204800	400000	counts/s
Gear ratio	-	29.6:1	-	-	-
Encoder resolution	50000	33111	2048	2000	Impulses/mm
Limit switch polarity	Active high	Active high	Active high	Active high	-

6.2.3 Operating Parameters of the Models with Stepper Motor

If you use a stepper motor controller from a third-party supplier, it may be necessary to enter operating parameters to adjust the used stage.

Parameter	M-5x1.2S1	Unit
Recommended start values:		
Holding current	200	mA
Operating current	600	mA
Holding current delay	500	ms
Max. motor current	850	mA
Max. acceleration	20000	steps/s ²
Max. velocity	20	mm/s
Max. velocity	8000	steps/s
Hardware properties:		
Limit switch polarity	Active high	-
Full steps	400	steps/revolution
Phase resistance	6.6	ohm
Max. phase current, bipolar	850	mA

7 Maintenance

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7.1 General Notes on Maintenance

NOTICE



Damage due to improper maintenance!

Improper maintenance can lead to misalignment and failure of the M-5x1.

- Only loosen screws according to the instructions in this manual.

7.2 Performing a Maintenance Run

Depending on the operating conditions and the period of use of the M-5x1, the following maintenance measures are required:

Maintenance run

The maintenance run serves to distribute the lubricant that is present.

- After 500 operating hours or at least after 1 year, carry out a maintenance run over the entire travel range, in order for the lubricant present to be equally distributed.
- If you operate your stage continuously over only a small working range (<20% of the entire travel range), perform a run across the entire travel range approximately every 2000 motion cycles.

Lubrication

Under laboratory conditions, the stage needs extra lubrication in exceptional cases only. For continuous industrial use, the lubrication intervals must be defined individually.

- Do not lubricate the M-5x1 without consulting our customer service department (p. 55).
- To lubricate, follow the instructions given in the maintenance manual which you can obtain from our customer service department.

7.3 Cleaning the M-5x1

Prerequisites

- ✓ You have disconnected the stage from the controller.

Cleaning the stage

- When necessary, clean the stage surface with a towel lightly dampened with a mild cleanser or disinfectant.
- Do **not** use any organic solvents.

8 Troubleshooting

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8.1 General Notes on Troubleshooting

For the M-5x1.DD1 and .DD2 models, the following applies:

CAUTION



Risk of glare and irritation!

The linear encoder of the M-5x1 uses a class 2 laser according to DIN EN60825-1:2007. Technical data of the laser: $L_{\max} \leq 1 \text{ mW}$, $\lambda=655 \text{ nm}$.

On delivery and if used according to the intended use of the M-5x1, the laser is fully shielded. Laser radiation can exit from the laser only if M-5x1 is opened. The laser beam can cause glare and irritation.

- Do **not** open or disassemble the M-5x1.
- Contact our customer service department if there is any malfunction of the M-5x1.

8.2 Possible Causes and Correction

Problem	Possible Causes	Solution
Reduced positioning accuracy	Warped base body	➤ Mount the M-5x1 on an even surface. The recommended evenness of the surface is 10 µm.
	When the M-5x1 is mounted vertically: The load exceeds the self-locking of the drive.	If you move loads of over 10 N when the M-5x1 is mounted vertically: ➤ Use a stage with a motor brake (M-5x1.DD2) or with a gearhead (M-5x1.DG1, .PG1).
	Increased wear due to small motions over a long period of time	➤ Carry out a maintenance run over the entire travel range (p. 47).
Functional impairment after system modification	<ul style="list-style-type: none"> ▪ Controller has been replaced. ▪ M-5x1 has been replaced with another model. 	Controller from PI: ➤ Load the parameters from the stage database that correspond to the combination of controller and M-5x1 model. Controller from a third-party supplier: ➤ Check the operating parameters.

Problem	Possible Causes	Solution
Mechanical system does not move; no operating noise can be heard.	Controller and/or power supply are not correctly connected or defective	<ul style="list-style-type: none"> ➤ Check all connection cables. ➤ Check the controller. ➤ If present: Check the power supply of the stage.
	When a PI controller is used: A motion error of the axis is present.	<p>Motion error = The difference between the current position and the commanded position exceeds the specified maximum value in closed-loop operation. Motion errors can be caused, for example, by malfunctions of the drive or the position sensor of the stage.</p> <ol style="list-style-type: none"> 1. Read out the error code of the controller in the PC software. If a motion error is present, the error code -1024 is output. 2. Check your system and make sure that all axes can be moved safely. 3. Switch on the servo mode for the affected axis in the PC software. <p>For details, see the user manual of the controller.</p>
	Moving platform has triggered the "inner" limit switch (p. 14).	<p>If you use a controller from PI:</p> <ol style="list-style-type: none"> 1. Switch on the servo mode for the affected axis again in the PC software. 2. Command an axis motion away from the limit switch in the PC software.
	Moving platform has triggered the "outer" limit switch (p. 14).	<ul style="list-style-type: none"> ➤ Manually move the moving platform away from the limit switch (p. 52).
In the case of models with a stepper motor: The mechanical system does not move any more but produces an operating noise.	The motor is overloaded by an external load torque or by the mass to be driven with a strong acceleration or delay.	<p>The motor skips steps. The information on the current position is lost without the controller recognizing this condition.</p> <ul style="list-style-type: none"> ➤ Determine the maximum velocity for a stage with a stepper motor in the application.

If the problem that occurred with your system is not listed in the table above or cannot be solved as described, contact our customer service department (p. 55).

8.3 Manually Moving the Moving Platform

NOTICE



Wear from manually moving the moving platform!

Manually moving the moving platform increases wear in the case of stages with a gearhead.

- With the M-5x1.DG1 and .PG1 models, only move the platform manually if there is no other possibility for motion.

INFORMATION

In the following cases, it can be necessary to manually move the moving platform:

- Make mounting holes for M4 screws accessible in the base body of the stage.
- Move the moving platform away from the outer limit switch in order to make the stage operational again.

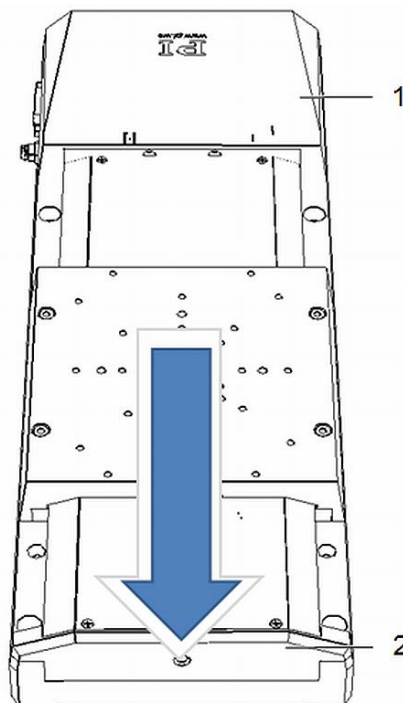


Figure 16: Position of the spindle access (cap removed)

- 1 Motor cover
- 2 Side part (front side)

Prerequisites

- ✓ The stage is **not** connected to the power supply and the controller.

Tools

- Allen wrench AF 3 (in the scope of delivery)

Manually moving the moving platform

1. Remove the cap of the spindle access in the front face of the stage (position see figure).
2. Introduce the Allen wrench into the spindle access until you feel resistance.
3. Rotate the Allen wrench as far as necessary:
 - Clockwise rotation: Platform moves away from the motor cover
 - Counter-clockwise rotation: Platform moves in the direction of the motor cover

The rotary motion is transferred directly to the ball screw.

9 Customer Service

For inquiries and orders, contact your PI sales engineer or send us an e-mail (<mailto:info@pi.ws>).

If you have questions concerning your system, have the following information ready:

- Product codes and serial numbers of all products in the system
- Firmware version of the controller (if present)
- Version of the driver or the software (if present)
- Operating system on the PC (if present)

The latest versions of the user manuals are available for download (p. 4) on our website.

10 Technical Data

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10.1 Specifications

10.1.1 Data Table

M-5x1 model	DD1 / DD2	EC	PD1	DG1 / PG1	2S1	Unit	Tolerance
Motion and positioning							
Travel range	M-511: 102 (4") / M-521: 204 (8") / M-531: 306 (12")					mm	
Integrated sensor	Linear encoder	Rotary encoder	Rotary encoder	Rotary encoder	-		
Sensor resolution	0.02 µm	4000	4000	2048	-	cts./rev.	
Design resolution	0.02	0.5	0.5	0.033	0.31	µm	typ.
Min. incremental motion	0.1	0.5	0.5	0.1	0.1	µm	typ.
Unidirectional repeatability	0.1	0.5	0.5	0.2	0.2	µm	typ.
Backlash	±0.2*	1	1	1	1	µm	typ.
Pitch / yaw	±25 / ±35 / ±35					µrad	
Straightness / flatness per 100 mm	1	1	1	1	1	µm	
Velocity	50	100	100	6	20	mm/s	max.

M-5x1 model	DD1 / DD2	EC	PD1	DG1 / PG1	2S1	Unit	Tolerance
Mechanical properties							
Thread pitch of recirculating ball screw	2	2	2	2	2	mm	
Gear ratio	-	-	-	$(28/12)^4 \sim 29.6:1$	-		
Load capacity	1000					N	max.
Push / pull force	80					N	max.
Permissible lateral force	200					N	max.
Drive properties							
Motor type	DC motor with PWM control	Brushless DC motor with PWM control	DC motor with PWM control	DC gear motor	2-phase stepper motor**		
Motor resolution	-	-	-	-	6400**	steps/rev.	
Guiding	Precision linear guiding rails, recirculating ball bearings						
Operating voltage	24 (PWM)	24 (PWM)	24 (PWM)	.DG1: 0 to ± 12 .PG1: 24 (PWM)	24	V	
Motor power	30	60	30	3	5	W	nominal
Torque	80	70	70	5	150	mNm	nominal
Reference point and limit switches	Hall effect	Hall effect	Hall effect	Hall effect	Hall effect		
Miscellaneous							
Operating temperature range	10 to 50	-20 to 65	-20 to 65	-20 to 65	-20 to 65	°C	
Material	Al (black anodized)						
Mass	5 (M-511) / 6.1 (M-521) / 7.2 (M-531)					kg	$\pm 5\%$
Connector	Sub-D 15-pin, 3 m cable incl. M8 4-pin (models DD1, DD2, EC, PG1, and PD1)						

M-5x1 model	DD1 / DD2	EC	PD1	DG1 / PG1	2S1	Unit	Tolerance
Recommended controller	C-863 C-884	C-863 C-884	C-863 C-884	C-863 C-884	C-663		




*Bidirectional repeatability for versions with linear encoder

**Max. 0.85 A/phase; 400 full steps/rev., motor resolution with C-663 stepper motor controller

Ask about custom designs!

10.1.2 Maximum Ratings

The M-5x1 stages are designed for the following operating data:

Device	Maximum Operating Voltage 	Operating Frequency 	Maximum Power Consumption 
M-5x1.DD1, .DD2, .EC, .PD1, .PG1	24 V	0 Hz	60 W
M-5x1.DG1	12 V	0 Hz	3 W
M-5x1.2S1	24 V	0 Hz	U * 0.85 A/phase

10.1.3 Ambient Conditions and Classifications

The following ambient conditions and classifications must be observed for the M-5x1:

M-5x1 model	.DD1, .DD2	.DG1, .PD1, .PG1, .EC, .2S1
Area of application	For indoor use only	
Maximum altitude	2000 m	
Relative humidity	Highest relative humidity 80% for temperatures up to 31°C Decreasing linearly to 50% relative humidity at 40°C	
Storage temperature	0°C to 60°C	0°C to 80°C
Transport temperature	0°C to 60°C	0°C to 80°C
Supply fluctuations	Not more than $\pm 10\%$ of the nominal voltage	
Degree of pollution	2	
Degree of protection according to IEC 60529	IP40	

10.1.4 Limit Switch Specifications

Type	Magnetic (Hall-effect) sensor
Supply voltage	+5 V/GND
Signal output	TTL level
Signal logic	High-active. The signal level changes when passing the limit switch. – Normal motor operation: low (0 V) – Limit switch reached: high (+5 V)

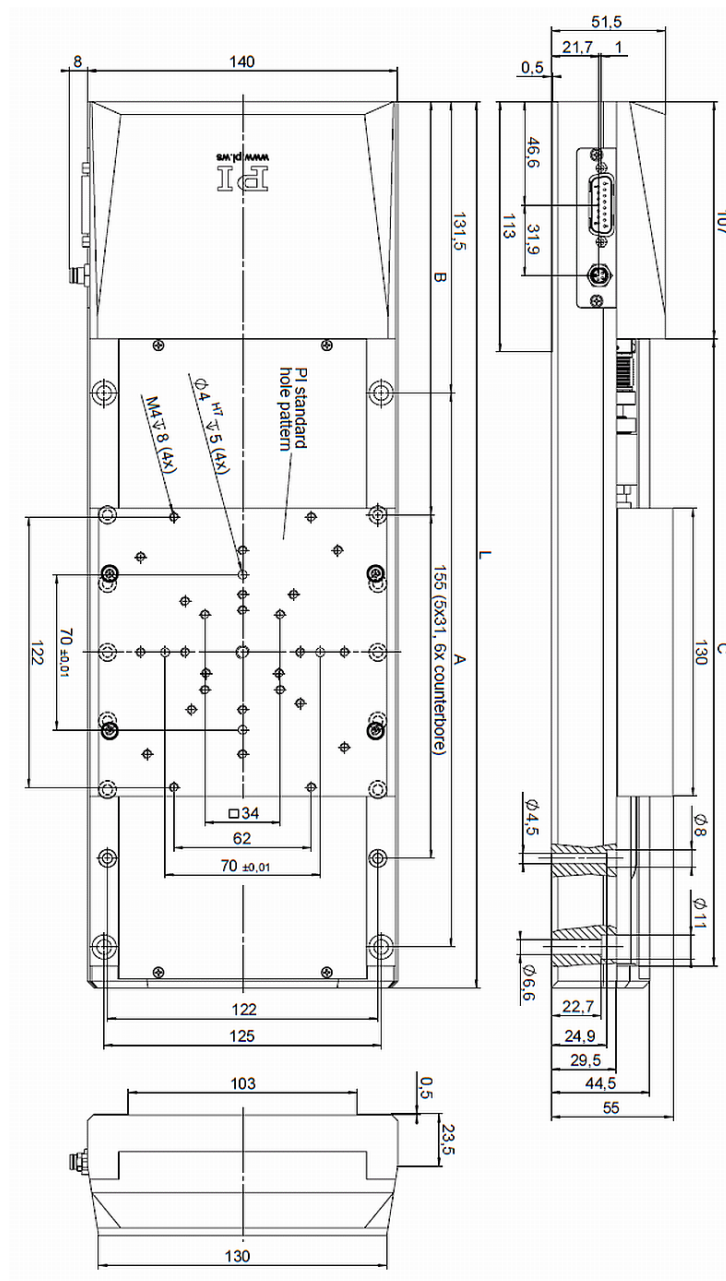
10.1.5 Reference Point Switch Specifications

Type	Magnetic (Hall-effect) sensor
Supply voltage	+5 V/GND
Signal output	TTL level
Signal logic	The signal level changes when passing the limit switch Direction sensing by means of different signal levels on the left and right side of the reference point switch: The signal level changes from 0 to +5 V when the reference point switch is passed.

10.2 Dimensions

10.2.1 M-5x1 Stage

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.



10.2.3 M-592.10 Adapter Bracket

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

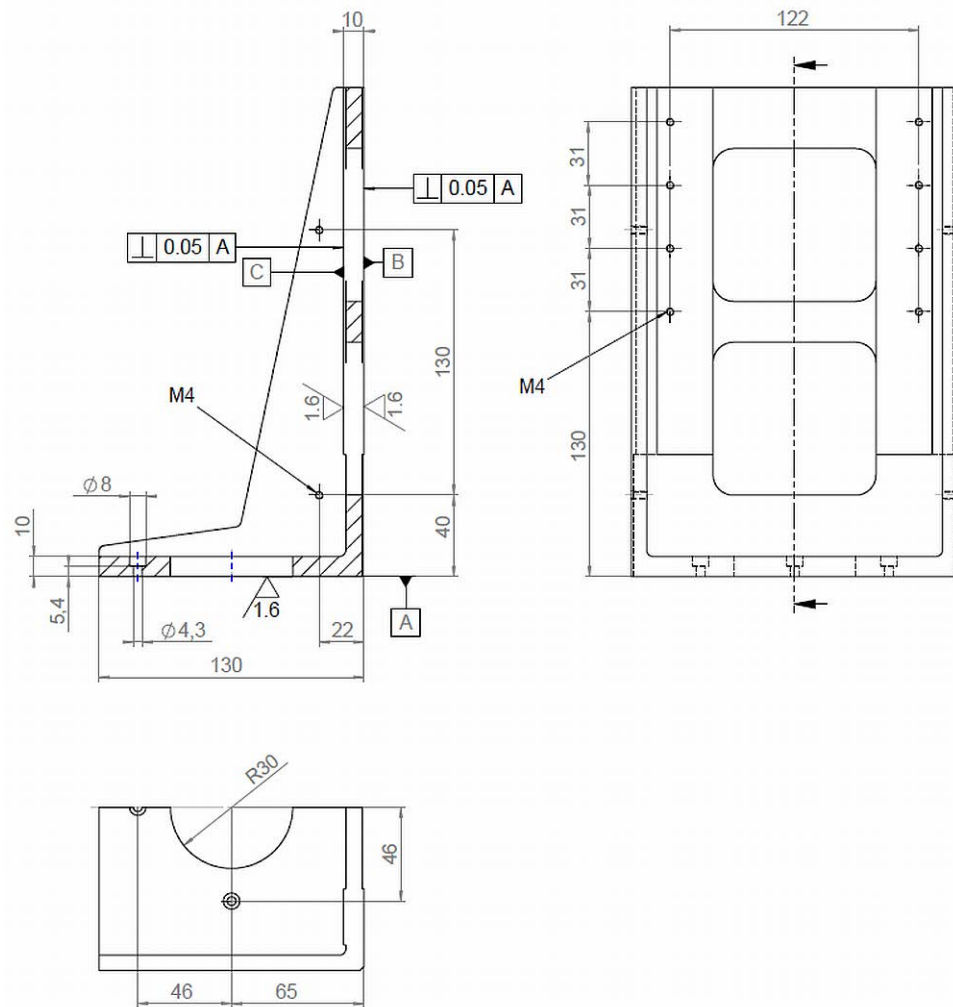


Figure 18: M-592.10 adapter bracket

10.2.4 M-500.206 Adapter Plate

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

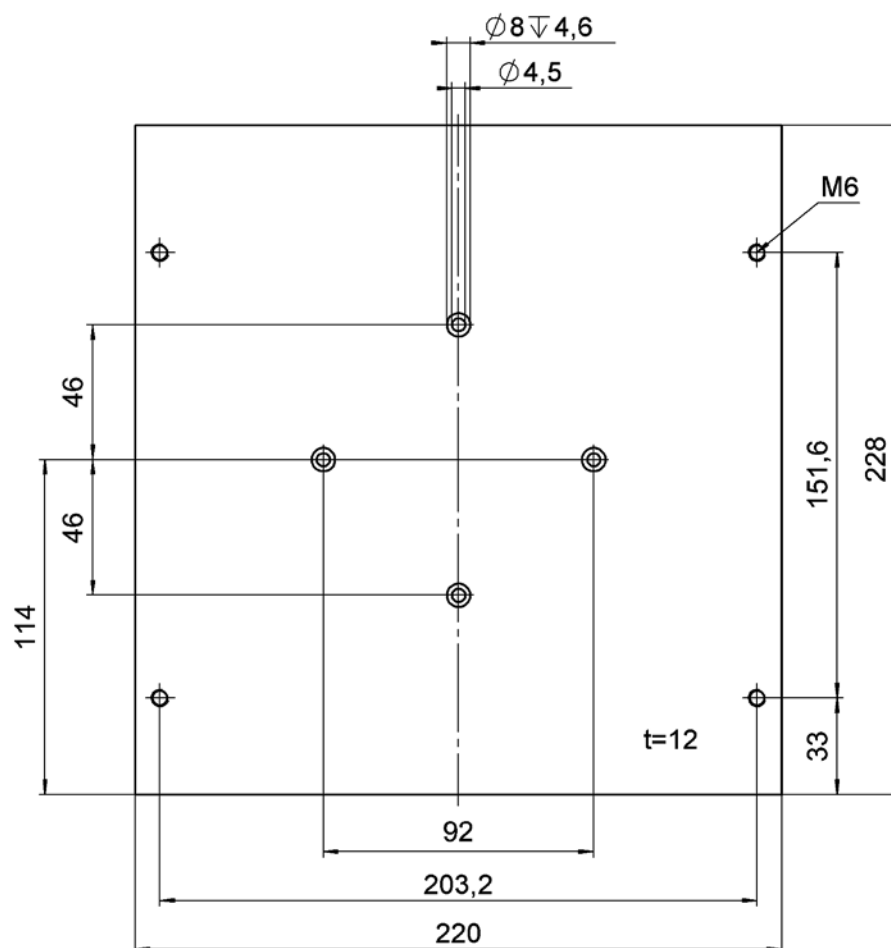


Figure 19: M-500.206 adapter plate

10.2.5 M-590.00 Three-Point Support, Two-Part

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

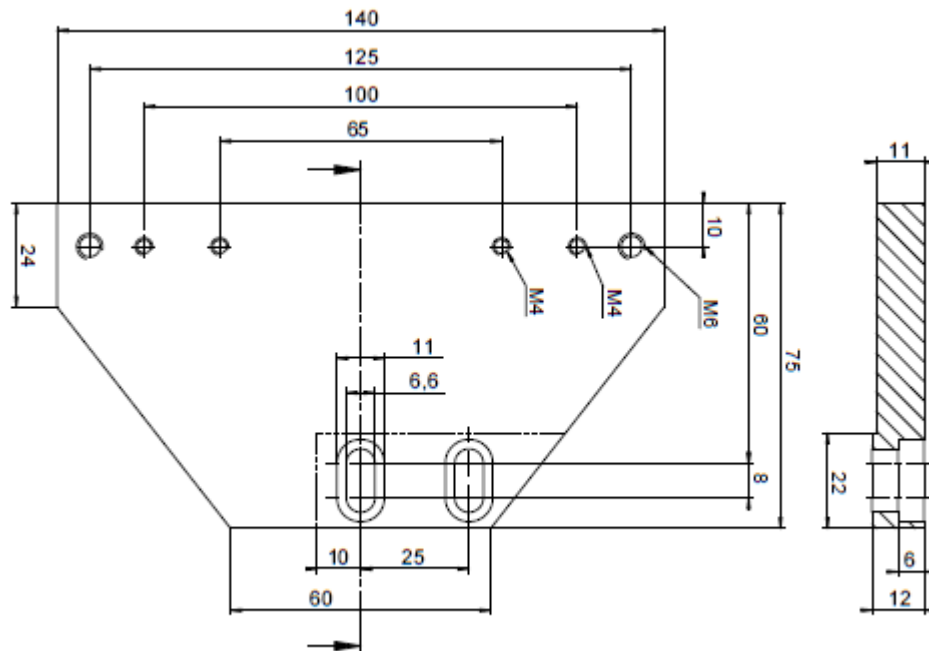


Figure 20: Wide adapter plate (M59000001)

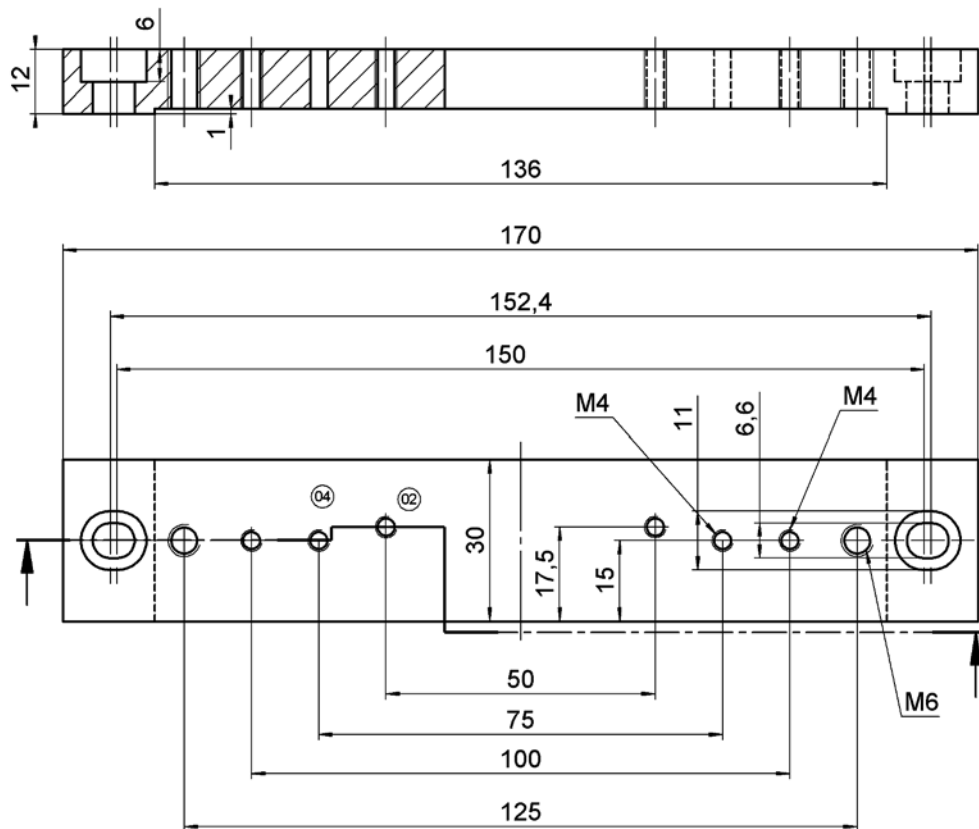


Figure 21: Narrow adapter plate (M59000002)

10.3 Pin Assignment

10.3.1 Sub-D (m) 15 Controller Connection

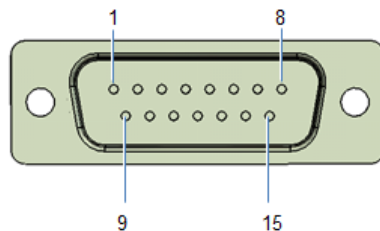


Figure 22: Sub-D 15 (m) controller connection, front view

Models with DC motor

Pin	Signal	Direction
1	M-5x1.DD2: Motor brake M-5x1.DD1, .PD1, .DG1, .PG1, .EC: Internal	Input
9	M-5x1.DG1: motor (-) M-5x1.DD1, .DD2, .PD1, .PG1: Internal; must not be connected M-5x1.EC: Not connected	Input
2	M-5x1.DG1: Motor (+) M-5x1.DD1, .DD2, .PD1, .PG1: Internal; must not be connected M-5x1.EC: Not connected	Input
10	GND	GND
3	M-5x1.DD1, .DD2, .PD1, .PG1, .EC: MAGN (PWM magnitude) M-5x1.DG1: Internal; must not be connected	Input
11	M-5x1.DD1, .DD2, .PD1, .PG1, .EC: SIGN (PWM sign) M-5x1.DG1: Internal; must not be connected	Input
4	+ 5 V	Input
12	Limit_N (negative limit switch)	Output
5	Limit_P (positive limit switch)	Output
13	Reference	Output
6	ID chip (for future use)	Bidirectional
14	Encoder A (+)	Output
7	Encoder A (-)	Output
15	Encoder B (+)	Output
8	Encoder B (-)	Output

Models with stepper motor

Pin	Signal	Direction
1	Motor phase 1A	Input
9	Motor phase 1B	Input
2	Motor phase 2A	Input
10	Motor phase 2B	Input
3	Not connected	-
11	Not connected	-
4	Not connected	-
12	Not connected	-
5	ID chip (for future use)	Bidirectional
13	Internal	Input
6	+5 V	Input
14	Limit_P (positive limit switch)	Output
7	GND	GND
15	Reference	Output
8	Limit_N (negative limit switch)	Output

10.3.2 M8 Power Supply Connector (m)

Connecting a power supply is only necessary with models M-5x1.DD1, .DD2, .EC, .PG1, and .PD1.

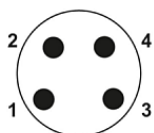


Figure 23: Phoenix M8 panel plug, front view

Pin	Signal	Direction
1	GND	GND
2	GND	GND
3	24 VDC supply voltage	Input
4	24 VDC supply voltage	Input

11 Old Equipment Disposal

In accordance with the applicable EU law, electrical and electronic equipment may not be disposed of with unsorted municipal wastes in the member states of the EU.

When disposing of your old equipment, observe the international, national and local rules and regulations.

To meet the manufacturer's product responsibility with regard to this product, Physik Instrumente (PI) GmbH & Co. KG ensures environmentally correct disposal of old PI equipment that was first put into circulation after 13 August 2005, free of charge.

If you have old PI equipment, you can send it postage-free to the following address:

Physik Instrumente (PI) GmbH & Co. KG
Auf der Römerstr. 1
D-76228 Karlsruhe, Germany



12 EU Declaration of Conformity

PI

Declaration of Conformity

according to DIN EN ISO/IEC 17050-1:2005

Manufacturer: Physik Instrumente (PI)
GmbH & Co. KG
Manufacturer's Address: Auf der Roemerstrasse 1
D-76228 Karlsruhe,
Germany



The manufacturer hereby declares that the product

Product Name: Heavy Duty Micropositioning Stages
Model Numbers: M-511, M-521, M-531
Product Options: all

complies with all relevant provisions of the Machinery Directive (2006/42/EC).
Furthermore, it complies with all provisions of the EMC Directive (2004/108/EC) as well as the
RoHS Directive (2011/65/EC).

The applied standards certifying the conformity are listed below.

Safety of Machinery: EN 12100:2010

Electrical Safety: EN 61010-1:2010

Electromagnetic Emission: EN 61000-6-3:2007, EN 55011:2009

Electromagnetic Immunity: EN 61000-6-1:2007

The person authorized to compile the technical file is: Michael Ebert
Address: see manufacturer's address

March 21, 2013
Karlsruhe, Germany



Norbert Ludwig
Managing Director

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